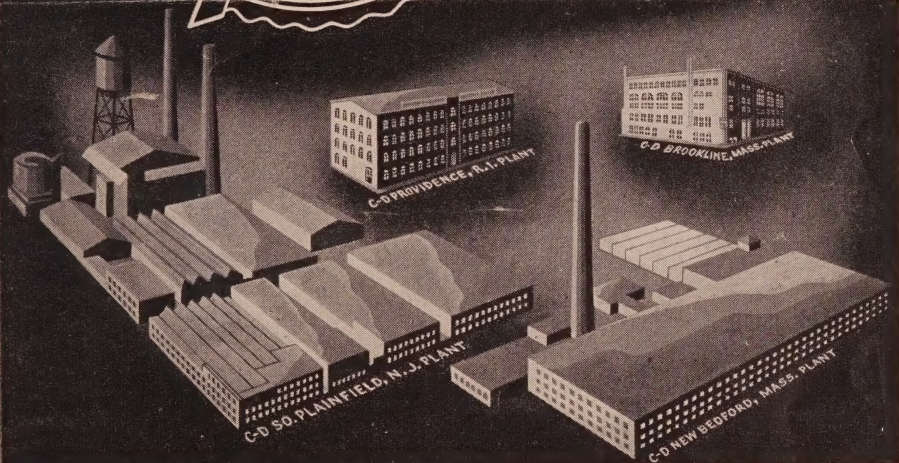


The CORNELL-DUBILIER *Capacitor*



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No. 9

CORNELL-DUBILIER ELECTRIC CORP.
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PHASE INVERTER CIRCUITS*

There is nothing new about phase inverters but with the advent of frequency modulation and television, high fidelity audio systems are becoming increasingly common. High fidelity reproduction requires the use of a push-pull audio power stage which, in turn, necessitates a phase inverter system. The author discusses those phase inverters which are most commonly encountered.

With the transition from transformer coupled audio amplifiers to those of the resistance type, the phase inverter has become increasingly more important. This importance will continue to grow as more and more frequency modulation receivers demand high fidelity amplifiers with resistance coupled output stages. Consequently, it is felt that a full explanation of the theoretical and practical aspects of this type of circuit will be found useful to the service engineer.

First, why is a phase inverter necessary? To understand this, it is important that we clarify the difference between a single-ended or "unbalanced" circuit and a double-ended or "balanced" type. Fig. 1 shows two simple load circuits. Suppose in each of these circuits we assume that a signal voltage is applied between points X and Z. In Fig. 1a, let's assume that at a given instant X is positive and Z is negative. This means that they have these polarities with respect to each other, and either one could be used as a reference. As soon as we ground Z as shown, however, we establish a fixed reference, or starting point. We then have only one "phase" or

direction of voltage available since signal voltages are measured with respect to ground. Point Z will now coincide with ground and our one phase exists at X (above ground) producing the single-ended type of circuit. Ordinary voltage amplifiers and detectors put out this type of signal.

Let us now take the same circuit and move the ground up to the midpoint of the resistor as shown in Fig.

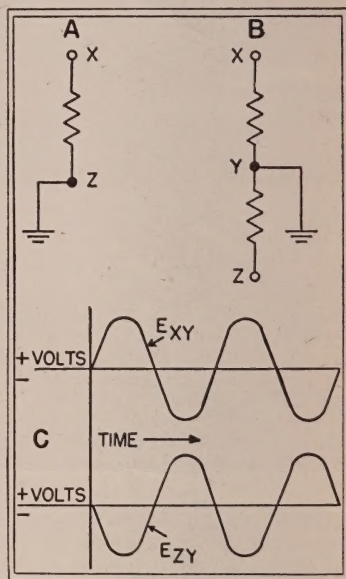


Fig. 1 A representation of single- and double-ended circuits. A represents the load circuit of a single-ended amplifier and B represents the load circuit of a double-ended amplifier. C shows the phase relationships of the voltage present in B when a sine wave signal is applied across points X and Y.

* By J. Richard Johnson in Radio Maintenance.

the positive direction. This will be accompanied by an increase in plate current, causing the voltage drop across the plate load resistor to increase. This increase in voltage drop causes the voltage at the plate itself to fall off. Thus, an increase in grid voltage causes a lowering of plate voltage, and a 180 degree phase relation therefore exists. Let us now consider some actual circuits in which this principle is put to work.

Probably the most popular inverter circuit is the type shown in Fig. 2. An ordinary single-ended resistance coupled amplifier is used in conjunction with an additional tube which gives the phase shift needed for the second output tube grid. Notice that except for the tap at point X and the use of a push-pull output transformer, the upper portion of Fig. 2 is simply a conventional resistance coupled amplifier.

Now some of the signal voltage applied to the output grid at point Y is tapped off at point X and fed into the grid of the phase inverter tube at point Z. The phase inverter grid now has a signal voltage of exactly the same phase as the grid of the top output tube but a lower voltage because it is tapped down on R1.

Because of the fundamental phase shifting property of a vacuum tube described above, the signal will appear in the plate circuit at M, not only amplified, but 180 degrees out of phase with the signal at point Z. This voltage is then passed on to point N, the grid of the lower output tube. Thus points Y and N have the opposite phase necessary for proper operation of the output stage. The only components which could change the exactness of the 180 degree relation are the coupling condensers. Since these are always chosen to have negligible reactance at the frequencies used, they do not disturb the relation.

But there is another important requirement. The voltages on the two output grids must be balanced; they must be equal. If balance is not obtained, the output wave form will not

be symmetrical and third harmonic distortion will appear. To preserve balance, the ratio of the signal voltages at points X and Y must be carefully adjusted in conjunction with the gain of the phase inverter tube. Since the voltage at X is amplified to produce the voltage at N, which should be equal to that at Y, it becomes clear that the ratio of the voltage at Y to that at X should equal the gain of the phase inverter tube. Of course, in any receiver using this type of circuit, the correct component values will be given on or with the circuit diagram,

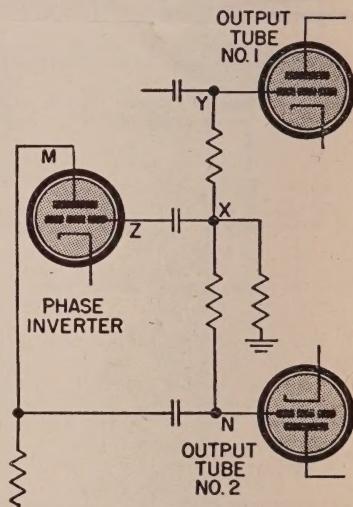


Fig. 3 A partial circuit diagram of the self-balancing type of phase inverter. In this circuit negative feed-back is used to balance the signals on the grids of the two tubes used in the phase inverter.

but the service engineer will find it worthwhile to understand the factors involved in the choice of the values of these components.

Self-Balancing Inverter

An important variation of this circuit is shown in Fig. 3. This is known as the **self-balancing** type of phase

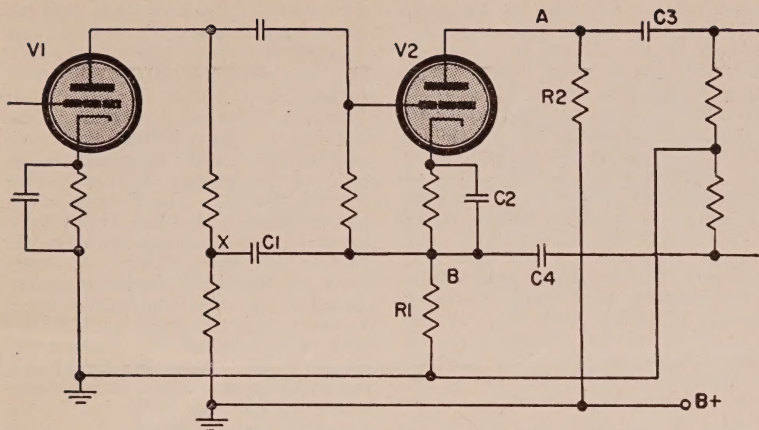


Fig. 4 A phase inverter utilizing the cathode follower principle. While this circuit requires only one triode, circuit values are much more critical than those of the two-tube phase inverters.

inverter. Since the main portion of the diagram would be the same as that described above, only the grid circuit of the push-pull amplifier is shown. Notice that the only difference here is that the low side of the grid resistor of output tube No. 2 now goes to the point X in Fig. 2, instead of directly to ground. This means that part of the voltage applied to the grid at point N is fed back (along with part of the voltage at point Y) through point X to the phase inverter tube through point Z. Since the voltages at points N and Y are out of phase with each other, the portion of the N voltage appearing at point X is degenerative feedback. This degeneration has a balancing effect on the two voltages. As soon as the voltage at N gets too large, the portion of it at X reduces the signal voltage on point Z, reducing the voltage at N, where it was originally too large. This design has the advantage that the division between the X and Y portions of the grid resistor of output tube No. 1 is not as critical as in the case of the first circuit described. It can be seen that if the three resistors involved in the grid circuit of the push-pull stage

are all made the same resistance, there will be 50 per cent negative feedback. This feedback not only helps to balance the signals on the two grids, but also gives the other advantages of degeneration in an audio amplifier.

The Cathode Follower

The cathode follower type of circuit is utilized as a phase inverter since it has the proper phase relation between plate and cathode voltages. The tube is connected as shown in Fig. 4.

Two plate circuit resistors, R1 and R2, are used, both of which carry the fluctuating plate current. One is connected between the plate and B+, the other between B— (ground) and the cathode resistor. Since a triode is normally used, there is no screen current and the same currents flow through R1 and R2. With ground connected between the resistors as shown, equal voltages with respect to ground will exist at points A and B. But, since the electron flow is toward ground through R1 and away from ground through R2, the voltages will be 180 degrees out of phase with each other. These voltages can be applied through coupling

condensers to the grids of the push-pull stage. Notice that since the cathode of the inverter tube must be operated with a signal voltage above ground, the grid signal voltage must vary with respect to cathode, rather than ground. An extra resistor is therefore added to the plate circuit of the previous stage to keep point X above ground potential. Condenser C1 ties point X to the cathode of V2 since C1 and C2 are chosen to have negligible reactance at the signal frequency. This keeps the grid voltage from having to work against the signal voltage appearing across R1. As explained above, the voltages across R1 and R2 are out of phase and are coupled through C3 and C4 to the output stage grids.

The big advantage of this circuit and ones similar to it is the fact that it requires one tube while those previously described require two. However, since dual triodes of the 6N7 and 6SC7 variety are readily obtainable, this is not always such a powerful argument in its favor. A disadvantage

of the single-tube inverter is that the circuit values are more critical than those of the two-tube type, and therefore can get out of balance more easily.

Another type of one-tube inverter is shown in Fig. 5. Here again, two resistors (R1 and R2) are used in the external plate-to-cathode circuit, but this time both are placed between B+ and the plate. The distinctive feature of this circuit is the fact that the grid of tube V3 is grounded. This may seem an impossible condition at first thought. It must be remembered, however, that the input voltage to a tube exists between the grid and the cathode. This means that we may run the grid at ground signal potential providing the cathode runs "hot" or at a voltage above ground. This gives the same effect as does running the grid at a negative potential with respect to ground when the cathode is as in Fig. 5. Now let's trace the signal through the diagram.

The input audio signal is applied at point A and is amplified in the

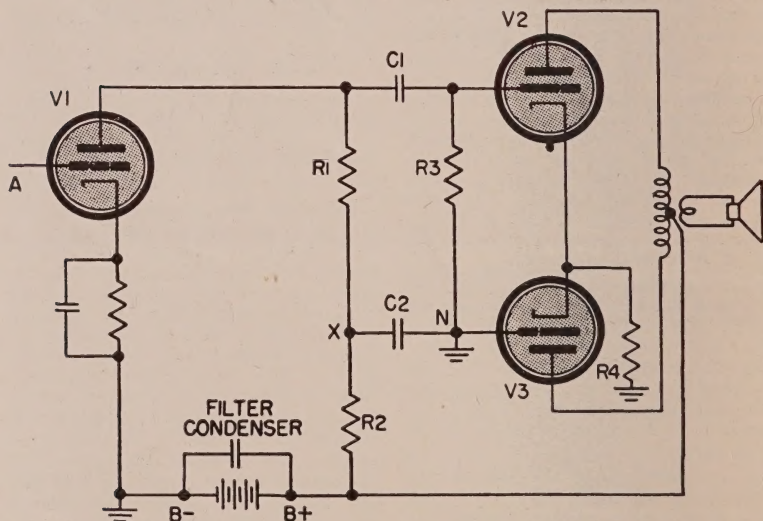


Fig. 5 A variation of the circuit shown in Fig. 4.

normal manner by tube V1. The amplified signal appears across the load resistors R1 and R2. This signal is fed to the grid of tube V2 through coupling condenser C1 and appears at point Y. The bottom of resistor R1 goes through condenser C2 to point N and ground. Thus, the signal between the top and bottom of resistor R1 is applied across resistor R3, and between grid of tube V2 and ground. Now V2 amplifies the signal and it appears as fluctuating plate current which is conducted through half of the output transformer, through the power supply, and back to the cathode of V2 through cathode resistor R4. Since no cathode by-pass condenser is used, these fluctuations produce a signal voltage across resistor R4. But R4 is connected between the grid and the cathode of tube V3 (through ground). This voltage is therefore the input signal to tube V3. Suppose we now check the phase relationships. When point Y gets more positive, more plate current flows through tube V2; this increase in current flows through R4 in such a way as to make the cathode more positive than ground. Since the cathode is more positive than the grid, the grid thus becomes more negative than the cathode. In this manner, we have opposing voltages at points Y and N at any given time—which is what we want to get from the phase inverter.

Notice that here again we have introduced some negative feedback as a by-product of our phase inverting process. This is true because the plate current of tube V3, as well as that of tube V2, flows through resistor R4. Since these two plate currents are 180 degrees out of phase with each other, they tend to balance out the voltage drops across R4 as far as signal fluctuations are concerned. Thus, a considerable amount of degeneration is taking place. It now becomes clear that this is another **self-balancing** circuit. But notice that it cannot be perfectly balanced because the input voltage to tube V3 is obtained as a result of unbalance of currents through resistor R4. Since the input voltage

necessary for the tube is usually very small, this unbalance is not serious, and this circuit is used successfully in several sets now on the market. The types of phase inverter described above are ones that you are most likely to run across in the course of service work. There are several other ways in which the same results may be obtained, but they are not much different from those described and work on the same principles.

Now that we have covered the theoretical aspects of the subject, let us investigate the practical realm of servicing technique involved in repair work on sets using the phase inverter. Of course, the inverter is essentially an audio amplifier; and, therefore, is subject to usual audio amplifier faults in addition to those which are peculiar to the phase inverter itself.

First, there is the possibility that the relatively critical relations between bias resistors and plate and grid resistors, as well as coupling condensers, might be upset by a change in value of one or more of these components. A number of these parts have a dual purpose, and thus small changes which would not necessarily be noticed in an ordinary amplifier can cause trouble. Carbon resistors will often age and change their value; this fact must be kept in mind when searching for trouble in these circuits. Don't let a qualitative reading on an ohmmeter give you a false sense of security about a resistor. Make sure it has the correct value within the tolerance required by the parts list. Condensers are not quite as critical as resistors; but if one of them is leaking excessively, the result may be distortion and loss of signal strength.

Second, there is the matter of balance. Aging of resistors can, of course, seriously affect the balance of the two voltages on the grids of the output stages. Even if all other things in the circuit are working perfectly, this factor will produce distortion in the output. Fig. 6 shows the type of wave form which results from unbal-

ance of the phase inverter circuit. One peak of the wave (A) has a higher value of voltage than the other peak

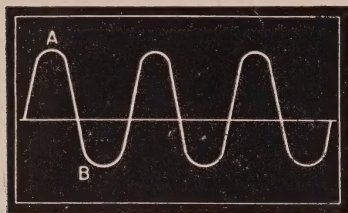


Fig. 6 Distortion of the wave form which results from an improperly balanced phase inverter circuit. The positive peak is of higher amplitude than the negative peak. This condition results in harmonic distortion.

(B). Thus harmonics, or voltages having twice, three times, etc., the fundamental frequency are produced in the output. The result is speech or music which has that "marbles in the mouth" or fuzzy or scratchy sound which is so often the cause of dismay on the part of the customer.

Having analyzed in a general way the possible causes of trouble, let's get more specific about symptoms and remedies. Since we are talking about phase inverters only, we must assume that the trouble has already been traced to that particular section of the receiver and that is where we are going to concentrate our efforts. Now for our symptoms.

No signal: Trace with an audio oscillator or a signal generator having an audio output. Start at the output grids, placing the audio voltage on one grid, then the other. Audio output from the speaker should be heard from either tube, although the gain of the power tubes is quite low so don't be alarmed if the output sounds quite weak. If the set itself is dead, it is quite unlikely that one of the output tubes will be any different from the other in this test since the proper operation of either one would produce some sort of signal. An exception to this, of course, would be

the case of a short in the common B+ lead. If the signal through the output stage seems to be okay, then we can move back a stage and try applying our signal to the grid of the inverter itself, depending upon whether it is of the one- or two-tube type. It is not likely that the inverter tube or circuit is at fault in the two-tube circuit since in this type (See Fig. 2) failure of the inverter itself will not prevent signal from going through the other tube (driver). On the other hand, failure of the driver tube in this setup would be just the thing likely to cause a complete loss of signal. When a single tube is used (See Fig. 4 and 5) naturally a defect almost anywhere in the circuit of this tube can be the cause.

Distorted signal: First, use the same method as described above, except that now we try to find the point at which the distortion starts. We should, of course, check all bias resistors and make sure that power supply voltages are proper. If none of these normal measures produces results, we should look for unbalance. If an audio oscillator with a good wave form is available, as well as an oscilloscope, we can follow the wave form through the circuit until we find the point at which distortion shows up in the wave shape. Perhaps a better way to check balance is to read signal voltages on the push-pull plates or grids. Put an audio signal into the input of the audio section; and with a condenser of about 0.05 ufd in series with the prod or lead from an AC voltmeter, check the voltages on the two push-pull plates. The difference between the voltages should not be more than 10 per cent. If they are okay, then the same test can be made on the grids. Here, we should use a high impedance meter, preferably a good vacuum tube voltmeter, since a low impedance meter will load down the grid whose voltage it is reading, and thus cause an unbalance which did not exist originally. We must not overlook the fact that unbalance can also be caused by a weak tube, especially in the two-tube

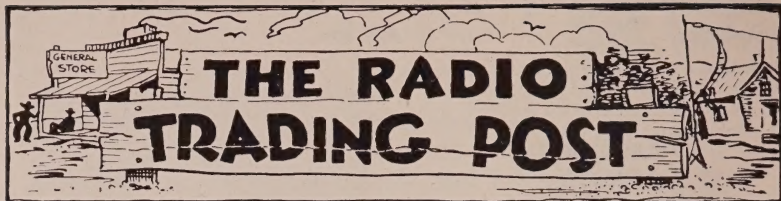
Symptom	Possible causes.	What to look for.
No signal	Power failure, shorted resistors or condensers, open resistors or output trans.	Check power supply including rectifier, filter condensers, choke, transformer. Burned out tube, shorted plate or grid resistors, open plate or grid resistors, open output transformer primary or secondary, speaker field or voice coil open, shorted coupling condensers, open cathode resistors.
Distortion	Unbalance, improper bias, impedance mis-match.	Cathode by-pass condensers shorted, open return on grid resistors. Plate, grid, or cathode resistors aged to improper resistance value. Weak inverter or driver tube. One half or some portion of output transformer shorted internally or to ground, speaker cone damaged, leaky coupling condenser, filter condenser losing capacity, decoupling condenser resistor shorted.
Low output	Weak tubes, low plate or fil. voltage.	Weak tube, leaky filter condenser, low filament voltage, shorted portion of bleeder resistor or output transformer primary.

variety of Fig. 2 and 3. It is worthy of note that the weakness of a tube which would ordinarily cause nothing more than low output now is a definite cause of distortion in inverters which are not of the "self-balancing" type.

Low output: All the ordinary causes of low output in an audio amplifier except those which would also cause

unbalance are to be suspected in this case. Weak tubes in self-balancing types or low supply voltages are possible causes.

The trouble chart herewith includes some of the more common troubles to look for in each case, although one should remember that there is no "cure-all" like understanding the circuits.



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WANTED—Copy of Cooke's "Mathematics for Electricians and Radiomen." Send price and condition. Paul E. Trued, Box 311, Sanford, Florida.

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FOR SALE—Three Western Electric Model 633A Microphones in excellent condition. These are high fidelity, 50 ohms, and are broadcast quality, the same microphone that is used by WOR and WNEW. Ideal for professional recording. Willing to demonstrate. Send \$40 money order for each one to I. Kaufman, 1650 Broadway, New York City.

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WANTED—8MM Novil camera and projector. Have Superior tube checker and Volt ohmmeter, Supreme condenser checker and bridge, 1 inch oscilloscope, amplifiers, microphones and Weston output meters to swap. Balsam Radio, 37-05 Junction Blvd., Corona, N. Y.

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WANTED—Philco chassis, No. 37-60 with or without speaker and cabinet. J. A. Collins, 2632 Washville St., Pittsburgh 4, Pa.

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WANTED—Converter, 110 A.C. to 6.3V. D.C. 5 or 10 amp. E. N. Howe, Box 1983, El Paso, Texas.

FOR SALE—Art 13 T-47A Transmitter in good condition less dynamotor, \$125 or best offer. Also pair new 864 tubes not in cartons. Hugh Ware, 11 Hillside St., Milton, Mass.

FOR SALE—Radio Store—all good new meters. Good line of stock. Must sell due to sickness. It is a nice business. Price is reasonable. Harry Snowden, 3921 E. 93 St., cor. Meech Ave., Cleveland, Ohio.

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FOR SALE—1 model 13A120D28-1, 800 cycle alternator, 1400 watts, 120 volts, 1 phase. 1 GE, type AS, 500 cycle alternator, 2KW, 110 volts, 1 phase, with exciter. Electric Maintenance Service Co., Inc., 143 Bennett Street, Bridgeport, Connecticut.

FOR SALE—1 Triplett model 666-H pocket Volt-Ohm Milliammeter; 1 Superior Signal Generator, model 650 (100 Kcs to 105 meg. and 400 cycle Ext. Mod. output), complete with leads and instructions. All condition. 4 25Z5 NU tubes in cartons. \$50.00 takes all. Harold Woodbury, Box 582, Pearisburg, Va.

FOR SALE — Radio Tubes, but most are not in cartons. 26, 27, 58, 25A6. Also "AC" Condenser Tester and Signal Tracer. 5 inch mag. spkrs., Rect. for 110 V. Speaker. Need 25B8 badly and a motor scooter seat. Write for information. All letters answered. Bill Denison, 9937 S. Carpenter St., Chicago 43, Illinois.

FOR SALE—Don't miss this bargain. Closing out our stock of 110 V., 1 ph. A. C. motors. Send \$2.00. Alko Labs., 333 East 95th Street, New York 28, N. Y.

FOR TRADE—3 line Cushion, Index, Rubber Stamp for one new or two used 1A7, 1N5, 1H5 or 1A5 tubes. Stamps must not have more than 30 letters in any line. Additional line 20c. Cookson, Lock Box O, Puxico, Mo.

FOR SALE — Midget Adding Machines. Flexible Flashlight Bulb Extensions enables you to see in every nook and corner. 6 inch 35c, 12 inch 50c, postage paid. John Keller, Radio Repair Service, South Market Street, Martinsburg, Pennsylvania.

SELL or TRADE—Model 695 Weston Power Level Meter and Indicator. Cost \$28.50, sell \$18 FOB. Mossberg .22 cal. Target Rifle Model 46A, 4 power Model 7 scope, special target stock with cheek rest, heavy 26 in. barrel, bolt action repeater, tubular magazine 15 L.R. ciges., plus adjustable peep and open sights, \$35 FOB. Both items excellent condition. Raymond H. Ives, 822 Windsor Ave., Norfolk 4, Va.

FOR SALE—1 Weston Analyzer model 779 type 1, new, price \$65. 1 Weston Output Meter model 571, new, price \$15. Also new Radio Parts, Tubes, Radio Kits, A.C. D.C. with tubes at \$11 each. Money order only. Peter P. Loden, 8749 Crispin Street, Holmesburg 36, Pa.

FOR SALE—Signal Tracer. Feiler TS-1 with Instruction and Batteries, less phones, \$5.00. Cost me \$12.00. Perfect condition. Ray Brown, 44 Arden St., New York 34, N. Y.

WANTED—Camera, preferably German make, rangefinder or reflex type. State make, size lens and shutter, and price. Walter Baer, 329 N. Duke Street, Lancaster, Pa.

FOR SALE—One R.C.A. Oscillator model 150 in good shape, just like new for only \$25.00. M. D. Banta, 541 Flower Street, Turlock California.

ATTENTION—I have mailing lists covering every city in the United States. If you are looking to advertise your items or location, directly to your local public, write to me. G. Samkofsky, 527 Bedford Ave., Brooklyn 11, N. Y.

FOR SALE—Heavy duty General Industries Phono Motor with 10 inch T.T., new, \$10.00, shipped prepaid; copy of "Modern Radio Servicing" by Ghirardi, never used, \$3.50, shipped prepaid. Norman C. Jensen, 7526 Harriet Ave. S., Minneapolis 9, Minnesota.

FOR SALE—Tubes: 6V6 metal tubes, regular list price, \$2.65—special nets, 1-49 only 65c each. List upon request. These are all new Kenrads in original sealed cartons. Nobo Company, Dept. 14, West Medford, 55, Mass.

FOR SALE OR EXCHANGE—Set of Dietzen Commander drawing instruments. Like new and in A-1 condition. Will sell or exchange. Am interested in a Weston Master Exposure Meter in good condition. A. Gasparino, 367 West 35th Street, New York 1, N. Y.

FOR SALE OR TRADE—S. X. 25 receiver with matching speaker, like new, instructograph senior, with 10 tapes, new, want test equipment, Riders manuals, Sams photo facts. What have you? F. E. Vaughn, P. O. Box 546, Eugene, Oregon.

FOR SALE—Dumont 5 inch Oscilloscope, Philco audio signal generator, small amplifier, 35 watt phone-cw transmitter. Wane Storch, Beecher, Ill.

FOR SALE—De-Luxe Midwest Radio, 16 tubes, A-1 condition—chassis, all tubes and speaker. Needs only re-alignment on high frequency bands. Price \$35.00. Diagram furnished. Nice for ham station. F. Bou, 3131 N. Percy St., Phila. 33, Pa.

FOR SALE—Supreme Signal Generator, Model 189, good condition, accurate. Best offer takes it. Sadler Radio, 4130 E. 12, Kansas City, Missouri.

FOR SALE—Radio Tubes from 45 to 60 per cent discount. List upon request. 55 and 65 cents. All guaranteed new. General Research Labs., 222 St. Marks Ave., Brooklyn 17, N. Y.

FOR SALE—Espey VTVM, also Espey Signal Generator, Signal Corps Spectacles. Both in excellent shape. \$45.00 each or \$80.00 for both. Also Dumont Scope No. 224A, cost \$245. What do you offer? Joseph Haas, 23-54—31st Ave., Astoria, Long Island.

SELL—G.R.L. Signal Tracer, uses 1T4, 1S5 and 3S4 with 4 inch Alnico No. 5 speaker in wooden cabinet. \$14.95. J. T. Cataldo, 602 Vanderbilt Ave., Brooklyn 17, N. Y.

SALE OR TRADE—A 5 inch or 7 inch television set, auto radio and bicycle for test equipment. J. Bazewick, 3000 Mo. Christiana, Chicago 18, Ill.

FOR SALE—Silvertone Portable Phonograph, slightly used, perfect, \$20; Phonograph Amplifier, new \$10; type 27 and 24 tubes, 50c each. Other articles. Frank Wyatt, 4610 Speedway, Austin, Texas.

WANTED—For lowest cash price, good, late model Oscilloscope, such as Supreme 546A 3 in. or Dumont model 274 5 in. or others. McKinley's Radio Service Zebulon, Ga.

FOR SALE—125 3 gauge TRF Condensers. All in factory cartons. Lot, \$135.00, or will trade for Chanalyst. National Radio, 409 Center St., Little Rock, Ark.

FOR SALE—Radio Service Dealer, Radio Retailing, Radio News, Service, Radio Maintenance Magazines from 1940 to 1947. Approximately 160 in all. Best cash offer takes any or all. Also some Radiocrafts. All are clean in good condition. Cassel Radio Service, RD No. 4, Irwin, Pa.

WANTED—To buy a set of Rider's Manuals. Write Mr. Harry S. Foster, 253 Miller St., Marengo, Iowa.

FOR SALE—Four tube record player. Has eight-inch speaker, Webster Chicago 56 changer and handsome leatherette cabinet. Will trade for multimeter or \$50 cash. Jack Pickle, 130 South Jackson St., Oakland City, Indiana.

WANTED—12K 8 tubes either new or surplus used. Will trade or pay cash. Wood Radio and Electric Shop, 2036 Chalfant St., Wilksburg, Pa.

FOR SALE—874 (and sub. for same) 3 tube amp, excellent condition. Tube tester meter out of Simpson 333 and also filament transf. Want—Riders—Vol. 10, 11 and 12. Saxton's Radio and Electric Service, Route 1, Pontiac, Ill.

FOR SALE OR TRADE—Pair of Western Electric 242-A tubes and pair of 205-D tubes in perfect shape. All inquiries answered. A. L. Oliveira, 94 Potomska Street, New Bedford, Mass.

FOR SALE—1 RCA 167B Oscillator used only twice. 2 Speakers, electrodynamic salvage from RCA-7 and Silvertone 4486 (101) 425. Have complete set of coils for these sets. 1 Hand Drill and several chokes and output transformers. 1 dual amp case large enough for 2 12 in. speakers, 3 supreme publications, diagrams, 1926, 1938, 1939, 1940. Sell for less than Osci. Cost \$53.00. Television antenna and 60 ft. of lead in. J. I. Freeman, 5025 Arch St., Phila. 39, Pa.

WANTED—BC-624 receiver from SCR-522, converted for 110 V.A.C. and hand-tuned instead of XTAL-controlled. Have SX-25 and LF-90, used but 200 hrs. \$75. and \$25. respectively. Paul L. West, Box 722, Martinsburg, W. Va.

FOR SALE OR TRADE—Radio shop in 6-room frame house close to 6000 acre lake in West Ark. Small tract land included. Value \$2500. Good battery district. National Radio, 409 Center, Little Rock, Ark.

SELL OR TRADE—Radio Service Business in North Hollywood, Cal. Complete will all best service equipment and stock. Rent 10 per cent. of net profit. Want new 1947 Chrysler or best offer. P. O. Box 1298, Hollywood 28, California. Karl H. Stello.

WANTED—Can \$15.00 buy a good used Signal Generator? Must have an "Audio out" Jack. T. Popel, 1223 Elm Ave., Brooklyn 30, N. Y.

WANTED—A used signal generator, low priced. G. E. E., Box 18, Geneva, Minnesota.

FOR SALE OR TRADE—German tubes and radio parts, also have some Italian Xtubes. All in good condition. Kellison Radio Service, Granby, Missouri.

TRADE—DeForest's complete correspondence course, on fundamental electronics, covering complete radio and television, worth over \$100, over hundred lessons. Want a VHF 152 converter for 2, 6, 10 and 11 meters or an R-9er in exchange, please write, Joseph Zukauskas, 2044 N. 3rd St., Phila., 22, Pa.

FOR SALE—25D8 tube substitution that works and will go into the Air Pals. Send \$1.00 for data on same. Electronics Industrial, 1619 E. Kellogg, Wichita, Kansas.

FOR SALE—1 Hickok Volt Ahm-milliammeter. Ranges upon request. Best offer. 1 Oscilloscope, Waterman's, model S-10-A, brand new, \$55.00. August Friel, 885 Cove Place, Glen Hazel Hgts., Pgh 7, Pa.

FOR SALE—Nationally advertised Radios, phono combinations. In original cartons. Write for prices. Carr Electric Products Co., 15-17 Kelley Square, Worcester 4, Mass.

FOR SALE—Neon sign, reads, Radio. Six inch letters, color border, including transformer. Write for price. Carr Electric Products Co., 15-17 Kelley Sq., Worcester 4, Mass.

WANTED — Automobile receiver, any model, providing vibrator unit and transformer are working. State model receiver, condition, and price. Any condition receiver providing High Voltage is working properly. A. L. Oliveira, 94 Potomska Street, New Bedford, Mass.

WANTED—Steel parts cabinets, small adding machine, industrial fluorescent fixtures. Have: Pontiac Car Radio, custom built push button fits 41 to 46 Pontiac. Also used car radios, small electric radios, new and used. Superior tube checker model 450. Children's new tricycles, scooters, Irish mail. Troch, Spotswood, N. J.

FOR SALE—Nationally HRO with Rack, 7 sets cons. 125 KC-30MC, \$125.00. Utah 25 watt Transmitter, xtal, tubes, coil, \$25.00. Meissner FM Tuner 41-51 mc, \$15.00. Utah H12P Speaker, \$23.00. Complete E.C.O. Part of BC325 Rig., \$60. Paul Wunsch, Jr., 387 Clifton Ave., Clifton, N. J.

FOR SALE—Meissner 3 tube A. C., D. C. radio, \$12.00; portable electric megaphone amplifier (with batteries; schematic, in metal box. \$20.00. Also DM-32-A dynamotor, new, \$1.00. Scott Gibson, 1337 3rd Ave., San Francisco, Calif.

FOR SALE OR TRADE—Converted BC 348q for Argus C3 camera. Albert E. Golem, 17 Grove Terrace, Tanawanda, New York.

WANTED—Riders Manuals Vol's 10, 11 and 12. E 200 precision sig. generator, late vibrator tester, Hallicraftes communication radios, and a 25 B8 tubes. Saxtons Radio and Electric Service, Route 1, Pontiac, Ill.

FOR SALE OR TRADE—Ost's 1943 volumes 1-12 minus 10 and 11. Also 1942 volumes 1-5 and 1, 12. All letter answered. Alan Kaufman, 12-23 Orchard St., Fair Lawn, N. J.

FOR SALE—Graflex No. 3A reflex camera. Takes pictures up to 1/1000th of a second. B&L f4.5 lens. Price \$35.00—Paramount professional tenor banjo, tuned as tenor guitar, cost \$275, in excellent condition, \$50. Gibson tenor banjo, \$25. Both in cases. M. Anshalt, 684 Whittier St., New York 54, N. Y.

WANTED—Motor scooter (Cushman preferred). Should be in reasonably good condition. Will pay cash for same or/ and will trade for test equipment, also have photo-electric relay unit and 3 tubes phono amplifier; Lionel trains, and lots of chemical (Inorganic). What have you? S. Hirsh, 386 Berriman St., Brooklyn 8, New York.

WANTED—Code machine, complete with practice tapes or can use a set of code practice records. Will pay cash or will trade for R.C.A. wireless phono oscillator, or complete set of Radio News Electronic Engineering, edition from 44 to 45. What have you? Berriman Radio, S. Hirsh, 386 Berriman St., Brooklyn 8, N. Y.

FOR SALE—Army Hamerlund Super Pro Model BC-779 less speaker \$150. 4 surplus BC-603 FM receivers, 20 to 28 mcs, rewired for 6 volt filament and tuned to 30 mcs, with 10 tubes and speaker \$19 each. John A. Wasiewicz, 14 "D" Coyne Park, Yonkers 5, N. Y.

FOR SALE—Pilot A. C. Super Wasp short wave receiver complete with original power pack and full coverage coils in perfect condition. Also have high voltage condensers, meters, carbon mikes, etc. Joseph J. Fusco, 330 W. Wilkey St., Phila. 23, Penna.

FOR SALE—Solid silver wire for uhf or jewelry, 16 gauge, guaranteed, \$1.25 roll. RCP mod. 448 multimeter, never used, \$20. Remington noiseless typewriter, almost new. One LS-3 spkr., one Jensen 8 in. spkr., perfect. All inquiries answered. R. J. Cartwright, 69 Mountfort St., Boston, Mass.

FOR SALE OR TRADE—1 signal tracer model CA10, used few times; 1 Stancor pack, 115 volts, 50-60 cycles, model U131, D. C., 7 volts, 6 S. A. George's Radio Service, 501 Central Ave., Jersey City 7, N. J.

TRADE—Weston Analyzer 697; Sky Buddy with extra tubes; numerous receiver tubes and parts; Stancor 25-B 20W CW Xmitter with 80 M Xtal; Weston O-300 DC MA; etc., for size 120 Enlarger w/ lens and easel. Vicinity offers only. Ray Vazquez, 20-40-149 St., White-stone, L. I., N. Y.

WANTED—German microscope objectives, Leitz or Wetzlar. Must be stamped "2- 6X". Will pay \$15.00 each or trade 5 meter 4 tube short wave receiver or Abbott Model DK3 Ultra S. W. Transceiver or tubes. H. P. Zeininger, 387 Washington St., Boston, Mass.

FOR SALE—Rubber Stamps — A 3 line Cushion Index 75c. Stamp must not have more than 30 letters in any line. Additional lines 20c each. For knob handle add 20c. Stamp Pad 60c. J.T. Cookson, Lock Box O, Puxico, Mo.

FOR SALE—3 model airplane motors—Super "60"; Ohlsson 60; and Barker 60. All practically new and in top condition. Will sell for \$30 or will trade for radio equipment. Bill Boone, 7, News-Record, Marshall, N. C.

FOR SALE—National Radio Institute tube checker \$40.00. Sylvania Polymeter with r. f. probe \$60.00. Both less than 4 months old. Perfect condition. Lloyd Dempsey, 2109 5th Ave. (rear), Huntington 1, W. Va.

FOR SALE—Astatic HP36 pickup \$13.95; HP 16 at \$13.95; Audax L 18 high at \$20.00; Audax D 38 High at \$25.00; Audax L17 High at \$13.95. These pickup arms are all new, in factory sealed cartons. Also have a few brand new ICA 85 watt soldering irons for only \$3.25. L. J. Melser, 1572 Harrison Street, Denver 3, Colorado.

WANTED—Serviceman, capable taking charge of service department, must be sober, honest and capable, good opportunity for the right man. Southern Radio Service, 124 E. Jackson St., Thomasville, Ga.

FOR SALE—Stroboscope discs, 2 5-8 in. dia. for use on records. Every speed from 50 to 110 RPM at 60 or 25 cycles. No dealer discounts. Write for information. Lewis Scriven, 24 So. Portland Ave., Brooklyn 17, N. Y.

TRADE—Radio tubes and parts for all kinds of good war surplus material. Also want typewriter and cox-axial speaker. All letters answered. R. W. Wood, 2036 Chalfant St., Wilkinsburg, Pa.

FOR SALE—Portable amplifier, 12 watt, complete with 5 tubes and 2 speakers, cost \$87.50, take \$50.00. Guaranteed like new. Sadler Radio, 4130 E. 12, Kansas City, Mo.

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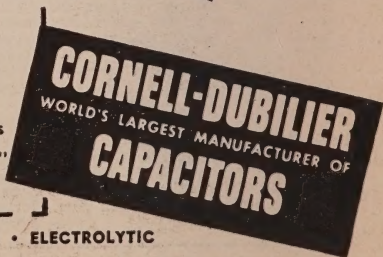
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